

# Wishing You A Very Merry Christmas and A Bright and Prosperous New Year



## Antifriction Bearing Lubricants

By O. L. MAAG, Lubricating Engineer

The Timken Roller Bearing Company

Presented Before the 9th Annual Meeting N. L. G. I.

A survey of lubricants used on antifriction bearings shows that, as with other types, we have two general classes: namely, greases and oils, the greases ranging in consistency from heavy products normally not over a No. 3 NLGI penetration to the semifluid ones; and the oils ranging in viscosity from light bodied spindle oils of around 70 seconds at 100° F. for lightly loaded, high speed units to heavy cylinder stocks of 200 seconds at 210° F., and in isolated cases even heavier ones for slower speeds and heavily loaded bearings. The housing design, type and efficiency of closures, speeds, loads and kind of service, wet or dry, all are factors governing the type lubricant to be recommended for best and most efficient service.

It is, therefore, evident that considerable thought from the lubrication angle must be given when laying out new bearing applications. You of the National Lubricating Grease Institute, being primarily manufacturers of greases, will be interested to learn that considerably over 50% of all antifriction bearing applications are lubricated with greases.

The question is often asked, which type of lubricant is best for antifriction bearings? The answer naturally is governed largely by the type of service or application in which the bearing is operating. We, and I believe other antifriction bearing makers, prefer oil to grease if designs and applications will permit, because—

1. You have a wider range of viscosities of oils to choose from for a wide range in speeds and loads of bearings.
2. When straight refined mineral oils can be used, you have the most stable lubricant obtainable.
3. The correct level or amount of lubricant can be more easily controlled by the use of the many oiling devices on the market.
4. If heating or cooling of the lubricant is necessary it can be done by the use of a circulating and cooling system.
5. There is little or no danger of an oil channeling under operating conditions and allowing a bearing to run dry and



burn up as long as there is oil in the housing.

6. With an oil film the surfaces are protected from rusting.

In the automotive field we have SAE numbers to designate different viscosity or bodied oils which undoubtedly is a step in the right direction. We recommend that such a number system be adopted, based also only on viscosity for industrial oils. It would simplify matters for the oil companies, and be a decided help to builders and users of equipment. Already we note a definite trend in the industrial field to recommend oils by SAE numbers or equivalents; therefore, feel this group could do a definite service by promoting such a system.

This group has certainly made a definite step in the right direction by their work in classifying greases by number and penetration. We do not contend that the present number and penetration ranges are just what they should be. Changes will likely be made as we gather field experience. We are inclined to believe at this time that a fewer number of greases can be used, also a better and more accurate method of determining consistencies will be worked out. The emergency the country is in should be a stimulus to all of us to use fewer grades of lubricants, to simplify servicing of equipment and avoid mixups.

Greases have advantages for certain type applications.

1. Not as efficient or as costly closures are needed where economy in design is required.
2. They will aid in forming a seal to keep water, dirt, etc., from getting into the bearings.
3. Grease stays put and does not need to be replenished so often on many types of installations.
4. Being heavier than oils they normally leave a better protective film on bearing surfaces for prevention of rust and corrosion under bad operating conditions.

#### Types of Greases

The most commonly used greases are of the lime soap type. This type of grease will function entirely satisfactorily on normal speeds and temperatures, and are very desirable where there is a moisture condition to be met. They are used on antifriction bearing units almost entirely on conveyor belts, mine cars, and other medium speed, low temperature, industrial applications.

Our recommendation from experience with this type service indicates that the following specifications can be used satisfactorily as a guide in making lime soap greases for normal applications.

#### LUBRICATION SPECIFICATION FOR MINE CARS AND MEDIUM SPEED INDUSTRIAL APPLICATIONS

The grease shall be a smooth, well-manufactured product, composed of a high grade soap and a refined, filtered mineral oil. It shall be free from corrosive matter, grit, rosin, waxes, talc, mica, graphite, clay or other fillers of any kind.

The grease shall conform to the following:

CONSISTENCY:..... No. 1 Grease 310-340  
No. 2 Grease 265-295  
No. 3 Grease 220-250

ASH: ..... Maximum 2 per cent.

MOISTURE: ..... Maximum 1 per cent.

CORROSION: A bright copper or steel plate shall show no discoloration after being submerged in the grease for 24 hours.

RESISTANCE TO WATER: It shall not emulsify readily with water.

The oils from which the grease is compounded shall conform to the following tests:

Flash Minimum 340°F.  
Fire Minimum 380°F.  
Viscosity Saybolt 300 Sec.  
at 100°F. Universal minimum  
Cold Test  
(Pour) Maximum +30°F.

Naturally for many applications a more limited specification must be drawn up to meet certain operating conditions.

#### Wheel Bearing Greases

Army equipment such as trucks, tanks, gun carriages, etc., are in need of a wheel bearing lubricant for year-round service. Experience over the years in buses, trucks, and other heavy duty equipment has been valuable in deciding what grease to use for this service. Our experience, which we believe you will find checks very closely with that of the builders of this equipment, indicates that a grease using the following outline as a guide will be entirely satisfactory for year-round service.

"The grease shall be composed only of soaps and oils, and shall be free from fillers and abrasives of any kind. It shall be non-corrosive to bearing parts in service or storage. It shall show no oil separation in storage or service. It shall be a smooth, cold-milled, short fibre, soda soap type grease of approximately 15% to 20% soap content. There is no objection to the presence of approximately 3% lime soap which will help to give a smooth, non-grainy structure to the grease. The moisture content should be not over 1/2%. The oil should have a viscosity of 75 to 100 seconds at 210°F., near 0°F. cold test and it should be a refined product. For normal application the grease should have an ASTM penetration at 77°

F. of not over 250 when applied to the bearings to prevent channeling. It should not work down below a 300 penetration in the grease worker or in service to prevent leakage under operating conditions."

You will note that this calls for practically an NLGI No. 2 grease. Naturally a grease can be made to pass such a specification and not be satisfactory in service; however, we feel that the manufacturers in addition to meeting a specification must use proper methods and materials in compounding to produce a good stable product.

Our experience with greases made from oils heavier in body than 100 seconds at 210°F. is that in cold weather in outside service you will have trouble with channeling and improper flow of grease to the bearings. Also, if the consistency of the grease is heavier than 250 when applied to the bearings you will experience the same trouble.

The following tests were made on greases sent in to our laboratory by our service men with reports on operation.

	ASTM Penetration as Received	60 Strokes in Grease Worker	300 Strokes in Grease Worker	Viscosity of Oil at 210°F.	Cold Test of Oil
A	250	260	260	84 Sec.	0°F.
B	245	245	250	109 Sec.	+15°F.
C	245	245	260	72 Sec.	+10°F.
D	225	270	295	68 Sec.	+10°F.
E	180	210	235	75 Sec.	+10°F.
F	235	275	325	78 Sec.	+10°F.
G	195	215	230	117 Sec.	+15°F.

Good all year-round service is reported for the first three lubricants. Samples D, E, and F were reported as giving leakage trouble, and on examination the lubricants in the hubs were semifluid, indicating that the milling action of bearings had thinned the lubricant. This might be expected of D and F, but we would not have expected it from E.

The above data indicate that with some products five workings, or 300 strokes in the grease worker, is not sufficient to tell the story in the laboratory of the stability of greases as regards consistency stability.

Also, as has been suggested to us by others interested in this problem, penetration tests should be made also at low temperatures to obtain data on how these greases will function in cold weather. You who have cold-room facilities should furnish these valuable data.

Service operating temperatures do at times go to 200°F. and higher. You should know what effect this has on your products as regards thickening, thinning out, gumming, etc. Some field observations indicated that we were getting channeling with lubricants which should not occur under the warm operating conditions encountered. Consistency determinations were made on a num-

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ber of greases before and after heating to  
225° F. with the following results:

## A. S. T. M. Penetrations

	New Grease	After 60 Strokes	Worked Grease Heated to 225°F. and Cooled
1	242	250	210
2	224	235	200
3	261	274	257
4	250	260	260

It seems to us evident why the first two greases were the "bad actors." The latter two greases were chosen because they had very good service records back of them for year-round use.

## Heavy Duty Mill Greases

For heavy duty bearings on the modern high speed steel mills three NLGI grades, Nos. 1, 2, and 3, are generally all that are needed, the large consumption being No. 1 for winter and No. 2 with some No. 3 for summer use. Here the mild type extreme pressure greases have over ten years of good service record. In the beginning the lime-lead-soap-sulphur type compounded from oils of 75 seconds to 100 seconds viscosity at 210° F. were the predominant ones used, and today are still extensively used. The lime-soap-sulphur-saponifiable types work

very well where the water conditions are exceptionally bad. Lime soap products compounded with heavy oils and with the sulphur and chlorine additives, such as are used for the all-purpose gear lubricants by the automotive trade, are being used with satisfactory results.

In mill operations we will apparently always have water, scale, and dirt conditions to contend with, and while closures, shields, etc., are being improved, considerable water still gets into the bearing housings. Some of the greases thin out very rapidly with 5% to 10% water, while others hold their original consistency quite well with as high as 15% to 20% water. Naturally the mill men are going to prefer the latter type grease, so what improvements you can make along the above lines will help materially.

For gear drives and roller bearings used in conjunction, all the above type lubricants made to fluid consistencies are being used with good results. Here again a standard uniform classification based on viscosity would be a decided benefit to both producer and consumer. Some of these extreme pressure lubricants, and particularly the newer ones, are apparently not as stable as they should be, particularly in the presence of moisture. There is need in some of these for the use of some good corrosion inhibitors in order to improve bearing operations.

## A. S. T. M. Standards on Petroleum Products and Lubricants

The 16th edition of this publication issued annually by the American Society for Testing Materials since 1926 provides in compact form all of the test methods, specifications, definitions and charts developed through the work of A.S.T.M. Committee D-2 on Petroleum Products and Lubricants. The 1941 book includes 69 methods of testing, 11 specifications, and 2 lists of definitions of terms. In addition, four proposed new methods, approved for publication as information and for comment, are given covering tests for neutralization number (by electrometric titration, and for crankcase oils), potential gum in aviation gasoline, and conversion of kinematic to Saybolt Furol viscosity. A revised Diesel fuel oil classification is also included.

Important new standards in the volume provide specifications for aviation gasoline and tests for knock characteristics of aviation fuels, standardized method of determining the ignition quality of Diesel fuels, and procedures for testing the aniline point of petroleum products and for carbonizable

(Continued on page 8)

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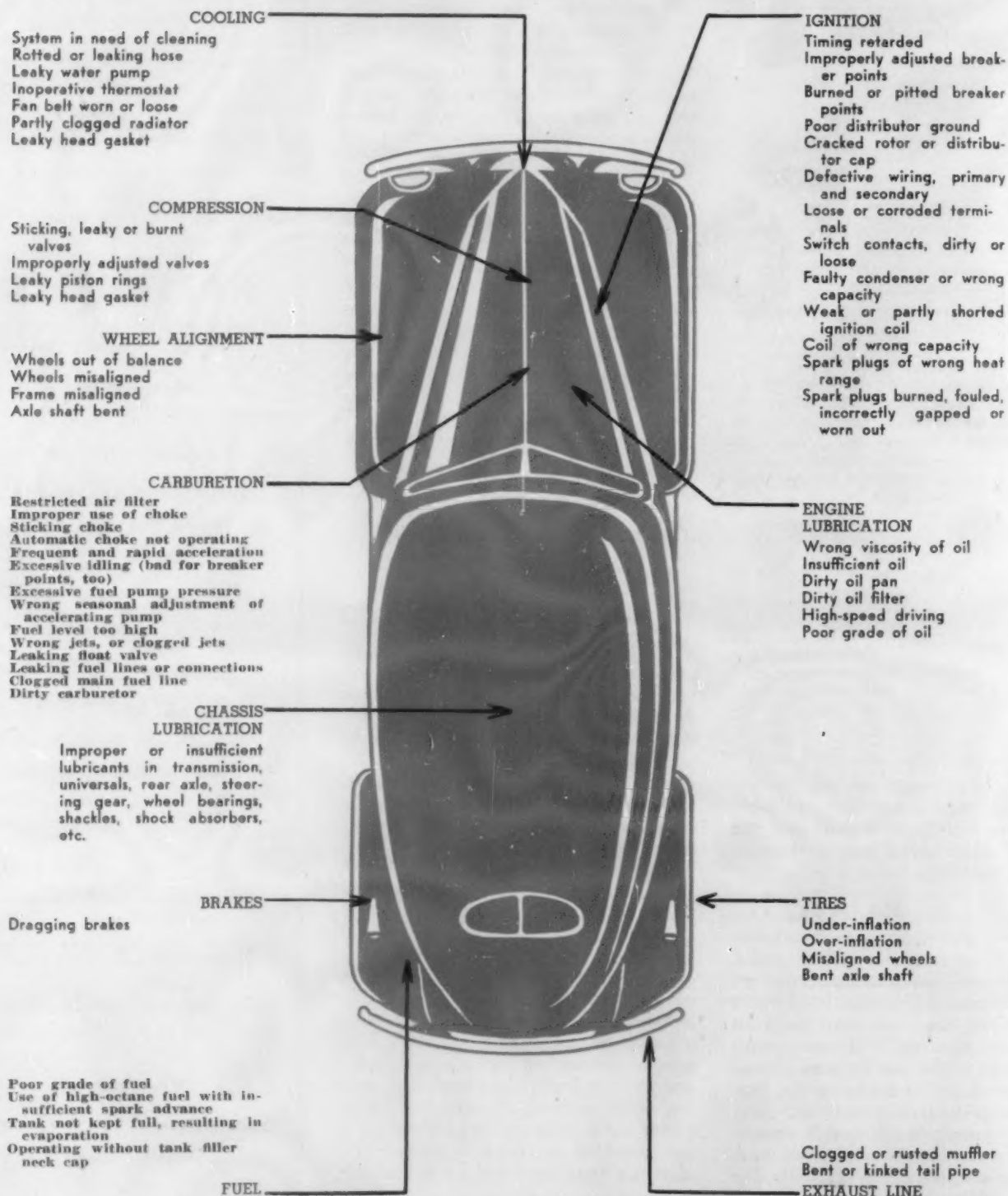
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# Additives for Petroleum Lubricants

DR. C. F. PRUTTON, Lubri-Zol Corp.

Presented Before the 9th Annual Meeting N. L. G. I.

During the past several years lubrication research has focused its attention largely on additives. We shall consider a lubricant additive to consist of a relatively pure chemical compound which is incorporated in a base lubricating oil to yield a lubricant possessing greatly enhanced lubricating qualities. Five years ago the use of lubricant additives was quite limited, and the nature of the additives in use and the products containing them were well known in the industry. In those days, anyone favoring widespread use of suitable additives found considerable opposition to their adoption:

Today the picture has changed and the last few strongholds of opposition to additives are rapidly being converted. Additives are being used on an ever increasing scale in a variety of products. Instead of employing additives only in those products where manufacturers' specifications or lubricant failures make them mandatory, additives are also being employed for the improvement of otherwise satisfactory products. Lubricants are thus given a "safety factor" in performance qualities which enables them to meet unusual operating conditions and changes in equipment design. At present, developments in this field are occurring with great rapidity and numerous patents are being issued. With such a rapidly changing picture it is well that one should periodically reconsider accomplishments,\* separate facts from conjectures and attempt to map out a logical path for present and future action.

## EARLY OILINESS ADDITIVES

First, we shall consider the actual accomplishments made in the field of lubricant additives. It is difficult to separate exactly the compounding of lubricants as practised for many years from the employment of additives. Compounded lubricants contain usually appreciable amounts of soap or fatty material and have been made from the early days of the industry. Several decades ago oils heated with sulfur yielded sulfurized oils for compounding, and later fish oil cooked with litharge yielded our first lead soap lubricants.

One of the first additives to be employed was oleic acid. Southcombe and Wells in 1920 recommended its use in small amount to improve the "oiliness" or friction characteristics of an oil. This idea was the forerunner of a lubricant in use today containing methyl dichlorostearate, and possessing "oili-

ness" and increased film strength, without the disadvantageous effects of the free acid.

## REFINING DEVELOPMENTS AND CORROSION INHIBITORS

In the 1920's and early 1930's many efforts were underway to prepare highly refined lubricants to meet the ever increasing requirements imposed upon them by changes in design. Power output, speeds, loads and temperatures were increased until improved lubricants were essential. To meet these new requirements the petroleum industry perfected and used a number of new refining processes. Solvent extraction, solvent dewaxing, new distillation methods, etc., were among the novel refining procedures all of which were employed in removing undesired constituents from lube oils.

Oils with lighter colors, with reduced tendency to oxidize, and with lower carbon residue forming materials were obtained. In many cases, however, these drastically refined oils when used in engine crankcases produced harmful oxidation products such as acids which corroded bearings, or varnish which deposited on rings or pistons to cause serious difficulties. Bearing corrosion troubles in the early 1930's were accentuated by the change from the conventional babbitt to copper-lead and cadmium-silver types of bearings. To eliminate bearing troubles, corrosion inhibitors were added to crankcase oils to greatly reduce their action on the bearing surfaces. Today a variety of lubricants contain corrosion inhibitors which are usually phosphorus, sulfur, nitrogen, or oxygen containing compounds.

## POUR POINT DEPRESSANTS

About a decade ago agents such as Paraffin were developed to reduce the pour point of wax-containing lubricants, thus avoiding the excessive costs of drastic dewaxing methods and at the same time retaining a valuable lubricating material of high viscosity index. Products of this type are used widely in the industry with excellent results.

## V. I. IMPROVERS

A highly desirable quality of a lubricant is its ability to maintain a fairly constant viscosity over a wide range of service temperatures. V. I. improvers such as the polybutenes, have been developed which greatly improve this characteristic of a lubricant.

## DETERGENTS AND ANTIOXIDANTS

It had long been appreciated in the field of diesel lubrication that maintenance of compression was essential to good operation. Since ring sticking, wear, and piston deposits had to be reduced it is logical that investigators in this field were first to discover additions which would inhibit the formation of harmful deposits. Here it was at first found that low V. I. oils with special soaps gave greatly improved engine performance. Earlier products were quite corrosive when used with sensitive types of alloy bearings, but this deficiency has been corrected during the last few years making it possible to use the detergent type of additive in many kinds of automotive crankcase service as well as in diesels.

Realizing that these soap additives functioned thru their dispersing action on oil oxidation and decomposition products, compounds other than soaps were soon introduced which functioned as detergents, or cleaning agents, and which in some cases were also oxidation and corrosion inhibitors. At present, products are available which serve this triple purpose in all types of diesel and heavy duty automotive engine service with excellent results. Their use is being extended further into the automotive field. By modifying solubilities of these additives it has been possible to have them function well in high V. I. oils and thus for the first time to have such oils accepted for lubrication of all kinds of diesel engines, as well as having them outstanding in the automotive field.

## EXTREME PRESSURE ADDITIVES

Although some preliminary work had been done prior to 1930, it was about that time that the automotive industry gave definite warnings that the hypoid gear would probably be widely adopted. This adoption made gear lubricants with high film strength an absolute necessity. Many test methods and products were studied and ultimately several types of very satisfactory hypoid lubricants were produced. Lead, chlorine, sulfur and phosphorus additive compounds were employed. These developments were striking cooperative accomplishments of the petroleum and automotive industry, producing a combination of gear and lubricant which have given excellent performance in service. Here was one of the first instances where an additive treated oil would perform sat-

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isfactorily and a straight mineral oil would not.

From the knowledge gained on film strength additives in gear lubricants, special additives have been developed to confer upon a variety of other types of lubricants, the safety factor of added film strength. In conjunction with oiliness agents, extreme pressure additives enable oils to function under thick film lubricating conditions, and continuously thru the thin film region up to moderately high loads.

**COOPERATIVE RESEARCH RESPONSIBLE**

Lubricants are essential to the operation of all machines. In the design and developments of new machines, the engineer must consider all of the materials of construction available, must make suitable compromises, and then design a new machine with improved performance characteristics. Since equipment improvements are mainly in the direction of lower weight, higher power, speeds and efficiency, it is logical that each component material in the final operating mechanism shall take increased stresses. Steels, alloys, plastics and all other structural materials have been greatly improved in their physical properties during the past two decades and have thus been of inestimable value to the engineer in the improvement of equipment. It was almost inevitable, then, that lubrication research should produce "super" lubricants in order to avoid being the "weakest link" in this chain of development.

Realizing the importance of lubricant improvement research men of the equipment industries have played a vital role in the development of additive treated oils. Thru the establishment of testing procedures, conferences and advice, they have brought to the lubricant manufacturer a picture of conditions to be met and difficulties to be encountered by the lubricant in the new machine. In several cases, test conditions have been established which have seemed to be almost too drastic, but consideration shows that a laboratory test to be of any value must be more severe than the average conditions of service, otherwise the test would have to be continued for years before obtaining an answer.

Research men of the equipment and automotive industries are usually in the best position to determine which products stand up best in service, and therefore should be best equipped to set up performance test procedures. Test conditions must be made additionally severe in order to obtain a major improvement in the products, so that an entirely new development program will not be required in the event minor changes are made in equipment or operating conditions. Thus, today's hypoid lubricants possess a considerable safety factor, and slight design changes, such as reducing sizes of gears,

could be accomplished without an entirely new research program to develop new hypoid lubricants. The lubricant industry is indeed grateful for the splendid cooperation and the vision of research men and engineers in the equipment and automotive industries.

**PRESENT AND FUTURE FOR ADDITIVES**

Having completed a brief historical sketch of additive developments, let us now consider several important questions on present and future trends.

**I. Why Use Additives?** One of the questions raised, or an implied doubt of people opposed to additives is "why should additives be used?" and secondly, "what logic is followed by those developing additives?"

Adoption of additives should be governed largely by economic considerations such as reduction of refining costs, increased sales by advertising a distinctly improved product, meeting of equipment manufacturers' specifications and thus retaining present business. These are some of the most important of the economic reasons for use of additives, or for any other change in lubricant products. It is true that in a few rare instances advertising claims have slightly outweighed performance of product and opponents of additives have used these few instances to cast doubt upon all additives. The instances have become increasingly rare because of the fact that in the past ten years the testing of lubricants has undergone a great change. With the extensive test setups now employed in evaluation of lubricants it has become difficult for an undesirable product to reach the market. Modern testing methods and laboratories stress lubricant performance characteristics rather than simply determining the degree and uniformity of refining used. Specialized laboratory tests are used to determine oxidation characteristics, corrosiveness, "oiliness", and film strength. Single cylinder and large scale engines are employed to determine how the product performs under a wide variety of conditions, and controlled field tests are used as a final check up. To stand up under such a searching examination a lubricant must possess outstanding qualities.

At present it is believed that petroleum oils may be "over-refined" to such an extent that they will oxidize readily to form corrosive acids and other harmful products. It is also believed that in such drastic refining, certain naturally occurring oxidation and corrosion inhibitors are removed, thus increasing the probability of bearing corrosion, ring sticking and deposit formation in service. Highly refined oils of this type which contain only the most stable and desirable hydro-carbons, yet being deficient in inhibitors are greatly improved by adding small

amounts of chemical compounds. These serve to inhibit corrosion, reduce oxidation and to keep any small amounts of oxidation products in a dispersed state. Still other compounds may be added to confer "oiliness" and film strength on the product. By careful synthesis, molecules of inhibitors much superior to the natural inhibitors can be prepared. Lubricants refined from petroleum oils do not contain effective detergents and yet when such cleaning agents are added, greatly improved service performance results. Resistance to rupture of lubricating oil films under extreme pressures can be imparted to an oil by adding oiliness and extreme pressure additives, and the product will then lubricate under conditions where any plain mineral oil would fail.

II. Is Use of Additives Only a Temporary Expedient? From our present knowledge it appears, as just stated, that the basic pure hydrocarbons in lubricating oils are not as resistant to deterioration as are products less perfectly refined and that further drastic refining will produce oils which will probably require corrosion and oxidation inhibitors as well as detergents. Thus further elimination of impurities from lube stocks by drastic refining may actually increase the need for additives. It seems logical that additives are here to stay and that their uses will increase.

III. Should Equipment be Designed to Operate on Straight Mineral Oils? Under modern competitive conditions, any industry that refuses to improve its products to the limit of its ability is doomed to certain trouble. The petroleum industry is not such an industry; it has always been one of the leaders in progressive research. Telling the equipment industries that they must design equipment to utilize only present products, would greatly limit the design of new and improved equipment. Improvements in materials of construction, fuels and lubricants, made possible the development of the modern automobile and other modern equipment, and still greater improvements may be expected in the future.

Just imagine the position of the steel industry, if it had stated years ago that plain steels were good enough and designers should change their design to use such materials instead of insisting upon special alloy steels of high strength. Improvement in equipment means an expansion in its use, and therefore the expansion of lube oil requirements. The number of passenger cars in this country increased from about eight million in 1920 to about thirty million in 1940, with a somewhat similar increase in lubricating oil sales.

Manufacturers of equipment have maintained a considerate and cooperative attitude when special lubricants are required. They have carried a large share of the research work on the development of such products,

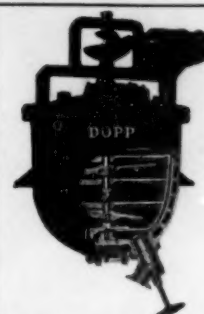
in developing test procedures, in testing of submitted products, setting up specifications and giving of advice to the petroleum industry.

IV. Assuming an additive treated oil is desired, should each company develop its own additives or would it be best to wait until some standardization of additives for a given use can be reached, and then purchase suitable additives?

This question is a difficult one to answer, but in general a large company that must maintain its position with regard to several important lubricant products, should undertake some research on additives. The patent picture in the field of additives, however, is becoming so complicated that it is questionable whether many of such research programs will result in securing patent monopolies on good additives for the company involved.

It is probable that within the next few years, additives for film strength, friction reduction, corrosion and oxidation inhibition, and for detergency, will become fairly well standardized, probably with a dozen or so in each class, with varying activities to meet various service requirements and the varying requirements of the base oils in which they are to be used. Under these conditions the incentive for individual company research may be somewhat reduced. At present there is a tremendous amount of additive research under way and this will continue for some time. For many small organizations it will be desirable to purchase additives or even additive-treated lubricants for resale.

V. In developing new additives, what principles are followed and what methods are employed? Since an additive is required to greatly accentuate some desired properties of a lubricant to meet some special service requirement, it is essential that a thorough understanding of service conditions and requirements be obtained. Here the counsel of engineers and research men of the equipment industries is of great value. They can present the problems, can give information on the difficulties that must be overcome, and in general have very definite ideas as



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to test methods for evaluating additive treated oils.

Tests are usually divided into:—

(a) Physical and Chemical Laboratory tests, such as Indiana and other oxidation and bearing corrosion tests designed to throw light on certain specific characteristics of the oil in a relatively short time.

(b) Engine or Mechanical Laboratory tests on various sized equipment units. For example, single cylinder engines followed by standard full scale engines are employed in testing crankcase lubricants. These tests must be of shorter duration than service usage; even 1000 hour tests are short compared to time in service, and therefore quite severe operating conditions must be employed. In many cases these engine tests are aimed at one objective such as the 4-cylinder Caterpillar diesel test which is employed chiefly for measuring bearing corrosion, while the single cylinder Caterpillar test gives ring sticking, wear and deposit information.

(c) Final tests in field service or on proving grounds under a wide variety of conditions.

From a knowledge of the problem and the requirements of the additive, a great number of possible additive compounds are synthesized and tested in several representative base oils. The preliminary laboratory tests eliminate only the ones completely unsuitable, then the tests on small scale equipment such as the small single cylinder engines eliminate all but the best of the group. These then go to the full scale engines in dynamometer tests and as they show promise are tested in full scale laboratory tests in various base stocks and then into field and service tests before being put on the market in the base stocks in which they have proven suitable.

After full scale laboratory tests on an additive in a particular base oil are satisfactorily completed, the product is usually submitted for approval to the engine laboratory of the equipment manufacturer, and then after completion of field and service tests, is finally ready for sale.

This is a lengthy and expensive test procedure to follow, particularly when thousands of additives and numerous base oils are to be investigated. Such thorough testing makes certain that only the best products will ultimately reach the market with approval.

VI. What effects do base stocks have upon performance of additive treated oils? One of the popular misconceptions about additives, in general, is that most any kind of a base oil may be used and the additive will take care of all the deficiencies of the

oil. It is essential that the lube oil refiner work with the additive supplier in developing a suitable base oil for blending. It is only when a properly selected additive is added to a high grade base oil that a very superior product is obtained. Even then the results depend upon the specific combination of a particular additive with a particular oil.

VII. If additives are to be employed, should they be used in all lubricants? Additives are used at present in many lubricating compositions and their use is spreading. Break-in oils, ball-bearing greases, chassis greases, hydraulic oils, turbine oils, machine lubricants, gear greases, cutting oils, and even quenching oils contain additives of at least one type, most frequently either oxidation inhibitors or film strength additives. Film strength additives provide a low cost safety factor in many cases, against film failure due to excessive and unexpected loads. Whenever a lubricant product must be greatly improved, serious consideration must be given to the use of additives.

#### SUMMARY

1. The petroleum industry must produce superior lubricants for the lubrication of modern equipment.
2. It is believed that further drastic refining of lubricating oil stocks alone will not produce these "super" lubricants.
3. It is believed that highly refined lube oils combined with additives will be used in producing such "super" lubricants.
4. Additives do not correct all of the deficiencies of poorly refined oils.
5. An additive must usually be tailor made to fit the base oil in which it is to be used.
6. The use of additives in all heavy duty lubricating compositions must be given serious consideration.

#### A.S.T.M. Standards on Petroleum Products and Lubricants

(Continued from page 3)

substances in paraffin wax. During the year some 13 standards were revised—full details are given in the annual report of Committee D-2 published in the compilation.

Copies of this 400-page book in heavy paper binding with two tables of contents, one listing the standards in order of numeric sequence, can be obtained from A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa., at \$2.00 per copy, with a price of \$1.50 in effect for ten or more copies.

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